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A FIELD TEST IN SOUTHEAST ALASKA OF BACILLUS THURINGIENSIS AGAINST THE BLACK-HEADED BUDWORM, ACLERIS VARIANA (FERN.)

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INTRODUCTION

The bacterium, *Bacillus thuringiensis* Berliner, commonly referred to as *B.t.* is toxic to many insects, especially larvae of moths and butterflies. Unlike many chemical insecticides that kill insects on contact, *B.t.* must be ingested by the insect to cause death. Thus, plant-feeding insects are especially susceptible and parasitic and predaceous insects are unlikely to be affected. A microbial pesticide such as *B.t.* offers the additional advantage, compared with chemical pesticides, of no known toxicity to birds, fish, and other animals.

Several companies manufacture formulations of *B.t.* under various trade names. This test used Thuricide 90TS Flowable[1] containing 30 billion viable spores of *B.t.* per gram.

An aerial spray trial was made in British Columbia in 1960 to control the black-headed budworm, *Acleris variana* Fern., with Thuricide SO-75.[2]

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[1] Manufactured by Bioferm Corporation, Wasco, California. Mention of a commercial product does not imply endorsement.

[2] Kinghorn, J. M. Notes on a Thuricide test against the black-headed budworm, Queen Charlotte Islands, British Columbia. Can. Dept. Agr., Forestry Biol. Lab., 5 pp. 1960.

Before spraying, a laboratory test showed that the black-headed budworm was susceptible to *B.t.* The field trial was inconclusive because a general decline in the budworm population occurred from other causes coincident with spraying. The authors concluded, however, that the budworm was susceptible to a commercially prepared formulation of *B.t.* , and that it was feasible to apply a lethal deposit from aircraft. They also concluded that an increase in effectiveness of aerial applications could be expected if the residual life of the material could be extended. The manufacturers claim that the new material, Thuricide 90TS Flowable, has a longer residual life than earlier formulations.

Cool summer temperatures, common to southeast Alaska, may limit the usefulness of some microbial pesticides which are inactive at low temperatures. All tests were carried out in the forest to learn whether Thuricide 90TS Flowable could kill larvae of the black-headed budworm under field conditions characterized by low temperatures and high humidities. Testing was done in Limestone Inlet, a bay 22 miles south of Juneau, Alaska.

METHODS

Water was added to the Thuricide 90TS Flowable aqueous suspension to obtain four different dilutions (table 1). A twig of western hemlock, *Tsuga heterophylla* (Raf.) Sarg., foliage was dipped in a flask containing a dilution, briefly air-dried, and placed in a plastic rearing cage. This was done for each of the four dilutions plus the check which contained only water. Into each cage, 10 apparently healthy larvae were introduced using sterilized forceps. The cages were numbered 1-5 and placed consecutively in a steel rearing tray partially filled with water. Each tray contained 10 cages, or two replicates for each dilution plus two checks. Test insects ranged from II to V instar.

At the completion of each test, samples of several dead larvae were examined to detect internal bacteria. The presence of vegetative rods confirmed the cause of death. The cause of death was not determined for insects in the check cages. However, no symptoms of bacterial contamination were noted in the checks.

Temperatures and relative humidities were recorded continuously with a hygrothermograph. The hygrothermograph and insect cages were in separate but similar weather shelters in the shade. Testing was done 4 times from July 14 to August 3 to cover the periods when larvae would be susceptible to spraying in the field. During this period the maximum air temperature was 72°; the minimum, 46°; and the mean was 56°. The maximum relative humidity was 100 percent; minimum, 42 percent; and the mean was 82 percent. The mean temperature for this period for the past 20 years was 56° according to official weather records. All temperatures are Fahrenheit.

RESULTS AND DISCUSSION

The percent mortality after 120 hours is shown in table 1. Mortality after 120 hours of exposure to *B.t.* concentrations of 1-20 and 1-100 was 80 percent and 84 percent, respectively. In all tests, the surviving insects were lethargic and not feeding. It is likely that many of the survivors would not have completed pupation and emerged to lay eggs. The percent mortality directly attributable to *B.t.* at the two highest concentrations is especially significant because surviving budworms in the field would also be subject to attack by natural controls not affected by *B.t.* Parasites, predators, and adverse weather along with the bacteria could cause a population collapse.

Replicates of each dilution were grouped by date of treatment. Chi-square analysis was used for each group to learn whether date of treatment had an effect on budworm mortality. Within each treatment, the group mortalities were not significantly different at the 5 percent level of probability.

Treatment mortalities were significantly different from the check at the 1 percent level of probability using chi-square analysis. Mortality of the 1-100 dilution was significantly different from mortality in the 1-500 dilution. However, there was no significant difference in mortalities between the 1-20 and 1-100 dilutions, or between the 1-500 and 1-1,000 dilutions.

No appreciable mortality occurred at exposures of 24 and 48 hours at any *B.t.* concentration. The relatively cool weather may account for the small percent mortality after 24 and 48 hours. All biological activity is slowed at cool temperatures.

The insects killed by the Thuricide were given to the Auke Bay Laboratory, Bureau of Commercial Fisheries, U. S. Fish and Wildlife Service. The dead, bacteria-filled insects were fed to coho salmon, *Oncorhynchus kisutch* (Walbaum), to determine any immediate gross effects. No adverse effects were observed.

If Thuricide 90TS Flowable does not cause any harmful effects on fish and other organisms such as clams and crabs, it should be tested further in coastal Alaska when budworm control is warranted.

Table 1.--Test of commercial *Bacillus thuringiensis* preparation against black-headed budworm larvae

Dilution (parts by volume of Bt to water)	Larvae tested	Mortality	
		120 hrs. following exposure	Corrected using Abbot's formula[1]
	Number	Percent	Percent
1- 20	180	80	77
1- 100	180	84	81
1- 500	180	60	54
1-1,000	180	58	51
Check	180	14	0

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[1] Corrected percent mortality =

$$\frac{\%\ \text{survival in check} - \%\ \text{survival in treatment}}{\%\ \text{survival in check}}$$

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